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Identifying and debunking environmental-related false news stories—An experimental study

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Abstract

Informed decisions are the cornerstone of a functioning democracy. The goal of this paper is twofold. First, to explore who is good at distinguishing between true and false, and, second, to learn something about mechanisms to debunk false news stories. In an experimental study, subjects were shown several news stories and asked to rate them as true or false. After this exercise, the subjects received systematically varied information about the correctness of the news stories depending on the experimental condition they had been assigned to. After a delay of three weeks, the subjects were shown the news stories again to find out which one works best. Our main findings are (i) The perceived familiarity with news stories increases the propensity to accept them as true. Actively open-minded thinking helps to distinguish between true and false. But the willingness to think deliberately does not seem to be important. (ii) By repeating false news stories, subjects are more likely to adequately identify them later (i.e., no evidence for a familiarity backfire effect). However, it decreased the ability to adequately identify correct news stories. A somewhat reverse, but weaker effect occurs when true stories are repeated: the correct identification of correct news stories is more successful, but the opposite holds for the identification of false news stories. Detailed explanations of why the false news stories contain false content increases the correct identification of false news stories, but the ability to correctly identify correct news stories is detrimental.

Keywords

False news stories; narratives; cognitive reflection test; actively open-minded thinking; environmental economics; experimental economics

JEL

C91 Laboratory, Individual Behavior

D91 Role and Effects of Psychological, Emotional, Social, and Cognitive Factors on Decision Making

Q50 Environmental Economics: General

1 Introduction

Informed decisions are the cornerstone of a functioning democracy (Pennycook et al. 2018). They enable people to debate about ideas (Waldman 2018). In contrast, false news stories¹ are not about ideas—they make it difficult to identify the true states of the world. The spread of false claims may reduce trust in traditional media and can lead to considerable misallocations and social damage. On the individual level, the costs of false news may include voting decisions that are not in line with one’s preferences, wrong investment decisions (i.e., negative pecuniary implications), or decisions against vaccination through erroneous decisions. On the societal level, misinformation and false news may have adverse consequences due to inadequate (political) measures or production decisions (cf., Pennycook et al. 2019). Since they are produced with the intention to increase monetary returns via clicks due to advertising or to support politicians, it is no surprise that false news circulate fast (Allcott and Gentzkow 2017; Napoli 2018). For example, Vosoughi et al (2018) examine the diffusion of true and false news stories on Twitter from 2006 to 2017 and find that false stories spread faster than true stories. They argue that this is due to the degree of novelty (false news stories are more novel) and emotional reactions of the recipients (e.g. false news inspire fear).

In general, it is desirable to constrain false news stories (Gruener 2019). This paper addresses two questions within this context. The first one is about determinants that can help to differentiate between false and true news stories. According to Allcott and Gentzkow (2017: 227), it is “both privately and socially valuable when people can infer the true state of the world.” However, detecting false news is a challenge. For example, Allcott and Gentzkow (2017) describe a possible trade-off between knowing the truth and conformity with one’s own priors (e.g. political attitudes). If, however, we can isolate basic human traits and their links to distinguishing between true and false news stories, the problem of false news stories may be mitigated to some extent. Let’s suppose that cognitive abilities are helpful here. In this case, it might be a good idea to consider intensifying human capacity building (i.e., education) to increase the individuals’ ability to evaluate the quality of news stories.

The second research question deals with behavioral effects resulting from the attempt to fix false news stories. How should false news stories be debunked? One approach could be to provide individuals with more information. The so-called information deficit model is based on the assumption that misperception is due to a lack of information. Accordingly, an increase in the amount of information provided would lead to better decisions (Cook and Lewandowsky 2011). The problem with this model, however, is that people generally do not process information in the way rational choice predicts (Grüner and Hirschauer 2019). For actual people, increasing the amount of information does not necessarily lead to better decisions. Correcting false news touches on the topic of how people update their prior beliefs. For example, repetition may make a false news story appear more familiar and thus more likely to be perceived as true. In addition, getting in touch with false news stories may undermine trust in the media as a whole. According to Lazer et al. (2018), there is a research gap in identifying the conditions where fact-checking activities are most effective.

¹ The term “fake news” is quite topical nowadays. Lazer et al. (2018: 1094) define fake news as “[...] fabricated information that mimics news media content in form but not in organizational process or intent. Fake news outlets, in turn, lack the news media’s editorial norms and processes for ensuring the accuracy and credibility of information.” In line with several other scholars (e.g. Wardle and Derakhshan 2017; Vosoughi et al. 2018), we avoid the somewhat ambiguous term “fake news” throughout this paper, and opt for “false news stories.”

The research questions outlined above are not new. However, existing studies on false news heavily deal with political topics. For example, Allcott and Gentzkow (2017), Guess et al. (2019), Pennycook and Rand (2019b), Pennycook et al. (2018), and Pennycook and Rand (2019c) primarily address the 2016 US presidential election. Moreover, the news stories are usually presented in the format of a Facebook post (i.e., headline + picture + byline + source). Our study adds value to the literature with spite to three points. First, it deals with environmental topics. Needless to say that these challenges (e.g. such as climate change, pollution, and food waste) require debates on how to combat them – a competition on ideas, not facts. Second, the experimental subjects are given news stories in the length of a small paragraph.² Third, in addition to psychological tests, socio-demographic aspects are also examined: these include, in particular, possible differences in gender. Experimental studies provide evidence that women are more risk-averse than men, women react more sensitively to social cues, and women have a higher aversion to competition (Croson and Gneezy 2009; Charness and Gneezy 2012).

The rest is structured as follows: Section 2 contains a brief literature review. The study design is described in Section 3. After describing the approach to data analysis (Section 4) and describing the experimental subjects (Section 5), the experiment findings will be presented in Section 6. Section 7 concludes and describes some limitations of the study.

2 Literature background

2.1 Who is good at distinguishing between true and false?

In their experimental studies, Pennycook and Rand (2019b: 48) find that “people fall for fake news because they *fail* to think.“ What does this mean? The starting point of their analysis is the dual-process theory (cf., Stanovich and West 2000), which distinguishes between autonomous, intuitive processes (System 1) and deliberate, analytic processes (System 2). To measure differences between intuitive and analytical thinking, they apply the cognitive reflection test (CRT), which has been introduced by Frederick (2005). This test uses questions, which have an intuitive but wrong answer; the correct answer often requires a second look at the task. Pennycook and Rand’s (2019b) central insight is that people who perform well in CRT are good at discerning between true and false news (with the exception of very complex scientific issues, where no effect was identified) when it comes to analyzing news headlines (incl. a picture and a short text of 1-2 sentences). To put it differently, being relatively successful in CRT does not make individuals more inclined to justify their prior beliefs, but instead leads to a better identification of false news (Pennycook and Rand 2019a). However, CRT has been used very often in the recent past and subjects may be familiar to the items. As a consequence, scholars are beginning to use modifications of the Frederick (2005) CRT version. For example, Thomson and Oppenheimer (2016) designed an alternative version of CRT. Indicating further research potential, Pennycook and Rand (2019b: 48) argue: “Further research is necessary to map the domains in which analytic thinking helps or hurts.”

Furthermore, there are some early studies that describe actively open-minded thinking (AOT; Haran et al. 2013; Baron et al. 2015) as a protective factor against the belief in false news stories. AOT captures the individuals’ willingness to revise beliefs and the search for alternative explanations (e.g. Bronstein et al. 2019). Similar to CRT, a high value on the AOT scale is positively related to the ability to discern false from correct news stories. Another finding is that those people who overclaim their knowledge tend to fall

² We do not provide subjects with the source of the news stories because recent research has shown that its place matters for subjects’ evaluation of news stories: people are less likely to trust news articles if the source is presented before the headline (“source-primacy format”) as compared to stories where the headline comes before the source (“headline-primacy format”) (Kim and Dennis 2019).

for false news stories (Pennycook and Rand 2019c). Furthermore, people seem to be relatively uncritical with news stories (i.e., more likely to believe them) that are in line with their political attitudes and other beliefs (Moravec et al. 2019; Pennycook and Rand 2019c). The latter can be explained with confirmation bias, broadly speaking, the tendency to hear only things that we want to hear (Lord et al. 1979). In line with that, Lazer et al. (2018) argue that people tend not to question the credibility of information (in contrast, they tend to accept information uncritically) unless it violates preconceived ideas or they face incentives to do so. Furthermore, the so-called illusory truth effect seems to be important. Pennycook et al. (2018) found that prior exposure to a statement increases the probability that it will be evaluated as correct. Even reading a fabricated news headline once increases the chance of being identified as correct after seeing it again. The background for this is that the processing fluency is increased through repetition and, thus, accuracy is derived. However, the illusory truth effect does not seem to matter with completely implausible statements.

2.2 Debunking false news information

As indicated above, debunking false news stories is a challenge. For example, increasing the amount of information provided to people does not necessarily make things better. In contrast, correction mechanisms that include the repetition of false news may even help the false news story to work stronger. The literature describes various constellations where corrections are ineffective or lead individuals to believe even more strongly in the false news stories. Non-intended effects as a result of a correction (i.e., increased adherence to the false news) are sometimes referred to as “backfire effect.” Among the more important backfire effects in the realm of false news stories are the familiarity backfire effect, overkill backfire effect, and the worldview backfire effect (Cook and Lewandowsky 2011; Lewandowsky 2012). The familiarity backfire effect addresses adverse effects that can occur when the false news is repeated in the course of its correction. Repetition increases familiarity with the false news item. This is problematic because there is a positive relationship between familiarity and accepting a story as true. However, recent studies raised some doubts about the robustness and importance of the familiarity backfire effect. For example, Pennycook et al. (2018) discuss studies in which familiarity due to corrections have had positive effects in distinguishing between true and false news stories. Correcting false news stories is not necessarily more successful the more counterarguments are brought forward (overkill backfire effect). It can even lead to an increased acceptance of the false news. More counterarguments require people to be willing and able to use more cognitive effort. Against the background that information is occasionally flooded in everyday life, it is not surprising if an increase in the supply of information is rejected (i.e., ignored). The worldview backfire effect describes situations in which the correction of false news stories generates contradictions to peoples’ beliefs or cultural identity. As a consequence, people may stick even more strongly to their “worldview.”

3 Design of the study

Overall, the study comprises two experiments (henceforth referred to as experiment 1 and experiment 2, respectively; cf., Table 1). In experiment 1, the subjects were shown 12 news stories from the environmental sector. The subjects’ most important task was to rate them as correct or false. To better understand the subjects’ answers, I collected data on a bunch of economic and psychological variables (e.g. attitude towards risk, spontaneously vs. deliberately manner of thinking, willingness to search for alternative explanations) as well as attitudes and opinions. At the end of experiment 1, subjects received information on whether the news stories were true or false. The amount of information as well as the manner of communication was determined by the treatment condition the subjects were assigned to.

After a period of 3 weeks after their participation in experiment 1, subjects were contacted again with the request to join a much shorter second experiment. In experiment 2, subjects were shown exactly the same 12 news stories from the environmental sector again and were asked to only evaluate the respective stories as correct or false.

Table 1. Study design at glance

Experiment 1	Experiment 2 (Follow-up session 3 weeks later)
<p>News stories on the environment and related questions</p> <ul style="list-style-type: none"> ▪ 12 environmental-related news stories ▪ Topics of the stories: assessment of risk and own knowledge ▪ General environmental-related questions <p>Psychological tests and sociodemographic variables</p> <ul style="list-style-type: none"> ▪ Cognitive reflection test (CRT) ▪ Actively open-minded thinking (AOT) ▪ Individual risk attitude ▪ Big 5 ▪ Sociodemographic and socioeconomic determinants <p>Treatment conditions</p> <ul style="list-style-type: none"> ▪ Information about the correctness of the stories 	<ul style="list-style-type: none"> ▪ 12 news stories from the environmental sector

Payment of the subjects

Subjects received €5 for their participation in experiment 1. In addition, two randomly selected subjects additionally received a payment of €50. Furthermore, three randomly selected subjects earned money depending on their decisions in the risk elicitation procedure. An additional show-up fee of €3 was paid to subjects who also joined experiment 2.

3.1 Experiment 1

(1) 12 news stories from the environmental sector

First of all, it was necessary to identify relevant topics from the variety of potential environmental issues. In doing so, I looked at statistics of environmental problems people are worried about. For example, the German online portal for statistics “statista” provides useful information on such issues.³ After the topics were determined, I was looking for corresponding stories. Roughly speaking, I searched for accurate news items and made some of them wrong. In total, 12 news stories have been examined. Half of them are correct, the other half contains some kind of false information. Table 2 gives an overview of the news stories. It provides a brief description of the stories presented to the subjects. Furthermore, contains information on whether manipulations have been carried out as well where the original story was published (more details and a translation of the stories can be found in Appendix A).

Story [1] describes various consequences of climate change. Deviating from the original source of the European Commission, a conjunction fallacy has been implemented. It asserts that it is more likely that climate change will lead to consequences x1 and x2 than that only consequence x1 will occur. Story [2] is about the amount of microplastics released into the environment. It was communicated to the subjects

³ <https://de.statista.com/statistik/daten/studie/4630/umfrage/wichtigste-umweltprobleme-in-deutschland/>

without changes to the original source. In Story [3], the meaning of the honey bee is illustrated by an incorrect quotation. According to it, human beings would disappear from the earth within a couple of years without bees. The quote is often mistakenly attributed to Albert Einstein. Here, the erroneous reference was made to an actual bee researcher. Story [4] tackles the consequences for the environment due to food waste. No manipulations to the original source have been made. Causes of bird deaths are the subject of story [5]. The relevance (i.e., number of deaths) of different causes (x_i) are described: it is argued that x_1 causes more victims than x_2 , x_2 causes more victims than x_3 , and, therefore, x_3 causes more victims than x_1 . In other words, it violates the transitivity assumption. Story [6] deals with the consequences of the reactor catastrophe of Chernobyl. With the help of mushrooms as an example, it is illustrated that even today radiation exposure can still be measured in Germany. Negative externalities due to air pollution are the subject of story [7]. It deals with deaths from nitrogen dioxide and ozone. Story [8] discusses ways to feed the world population. Contrary to the authors' key statement that organic farming cannot feed the world population entirely, the fabricated story claims exactly the opposite. In story [9], the challenge of disposable cups corresponding with coffee to go is tackled. It reports non-manipulated evidence for Germany in 2016. Story [10] is about the use of airplanes. On the one hand, politicians recommend not to use airplanes. On the other hand, they predominantly travel by airplanes themselves. Compared to the original source, the numbers on the use of the airplane by politicians have been considerably exaggerated. Story [11] describes the problem of waste being exported from Germany to other countries. It refers to current studies. The last news item [story 12] deals with smoking: in stark contrast to the authors of the original study, the manipulated news story presented to the experimental subjects claims that the authors call for a complete ban on cigarettes sold without filters.

Table 2. Description of the news stories

Nr.	Label	Short description	Adopted without manipulations? (“correct story”)	Type of manipulation (if applicable)	Source (of the non-manipulated story)
1	Consequences of climate change	Negative implications of climate change	No	Conjunction fallacy	European Commission
2	Microplastics	Amount of M. released into the environment	Yes	-	Spiegel Online
3	Importance of the honey bee	Meaning of the bee: no humans without bees	No	Exaggeration [Quotation: No humans without bees]	(Various)
4	Food waste	Consequences of food waste for the environment	Yes	-	German Environment Agency
5	Causes of bird deaths	Several reasons for bird deaths: wind turbines are pronounced	No	Violation of transitivity	NABU (Nature And Biodiversity Conservation Union)
6	Mushrooms and consequences of Chernobyl	Relationship of Chernobyl and radiation exposure (example: mushrooms in Germany)	Yes	-	Consumer Advice Centre (North Rhine-Westphalia)
7	Air quality	Negative consequences due to nitrogen dioxide and ozone	Yes	-	Deutsches Ärzteblatt
8	Nutrition of the world population	Chances of organic farming to maintain current standards	No	Opposite sign of the relevant effect	Spiegel Online
9	Use of coffee paper cups	Coffee to go and the corresponding disposable cups	Yes	-	Sueddeutsche Zeitung
10	Use of airplane for passenger transport	Trade-off: politicians recommend not to use airplanes but use it themselves considerably	No	Exaggeration (more extreme representation)	BR Online
11	Waste exports	Evidence on waste export from Germany into other countries	Yes	-	Handelsblatt Online
12	Smoking	Discussion of cigarettes with(out) filters	No	Opposite sign of the relevant effect	Deutsches Ärzteblatt

(2) Topics of the stories: assessment of risk and own knowledge

We collected further details regarding the essential parts of the news stories, which are indicated by the labels of the respective stories (e.g. “consequences of climate change”; cf., Table 2). More specifically, we asked the subjects to evaluate the risks and dangers for the environment/society as well as to rate their knowledge.

(3) General environmental-related questions

The experimental subjects were asked to assess their expertise in environmental issues in general. They should also indicate whether they think they are better or worse informed about such issues than the average student of the Martin Luther University Halle-Wittenberg. In addition, participants gave answers on how often they talk to friends about environmental challenges, and how they describe the public discourse on environmental issues (either value-based or an open exchange of perspectives).

(4) Cognitive reflection test (CRT)

Frederick (2005) introduced a psychological test to classify people as more intuitive or more deliberate thinkers. The items of the test follow a pattern: a quick answer is intuitively plausible but mathematically wrong. Deliberate thinking usually leads to the identification of the correct answer. The higher the score on the CRT scale, the more are people classified as deliberate thinkers. Frederick’s scale has been used extensively in experimental studies, and it is therefore conceivable that the subjects are familiar with it. Therefore, I rely on modified items from different sources (Baron et al. 2015: 266; Thomson and Oppenheimer 2016: 101; Frederick 2005: 27). To give an example: “Soup and salad cost €5.50 in total. The soup costs a dollar more than the salad. How much does the salad cost?” (Baron et al. 2015: 266). The intuitive, but wrong answer is €2.50; the correct one is €2.25.

(5) Actively open-minded thinking (AOT)

AOT measures the extent to which individuals actively seek for alternative explanations and whether they use evidence to adjust their beliefs. I adopt the 7-item scale from Haran et al. (2013). The subjects had to rate themselves on a scale ranging from 1 (completely disagree) to 7 (completely agree). For example, item 1 reads as follows: “Allowing oneself to be convinced by an opposing argument is a sign of good character.” (Haran et al. 2013: 201).

(6) Individual risk attitude

To elicit the individuals’ risk attitude, we use the procedure according to Eckel and Grossman (Eckel and Grossman 2002, Dave et al. 2010; see Table 3). The basic idea is that the subjects are required to pick one out of 6 gambles. In each gamble, there is a 50% probability of a (relatively) low payoff and a 50% probability of a (relatively) high payoff. The gambles systematically vary in the expected payoffs and standard deviations: an increase in the expected payoff goes along with an increase in the standard deviation. Subjects are classified as risk-averse if they select one of the gamble 1-4, risk-neutral if they pick gamble 5, and risk-seeking if they opt for gamble 6.

Table 3. Eliciting the individuals' risk-attitude (Eckel-Grossman gamble choices)^(a)

Choice (50/50 gamble)	Low payoff	High payoff	Expected payoff	Standard deviation	Implied CRRA range
Gamble 1	28	28	28	0	$3.46 < r$
Gamble 2	24	36	30	6	$1.16 < r < 3.46$
Gamble 3	20	44	32	12	$0.71 < r < 1.16$
Gamble 4	16	52	34	18	$0.50 < r < 0.71$
Gamble 5	12	60	36	24	$0 < r < 0.50$
Gamble 6	2	70	36	34	$r < 0$

(a) The last three columns were not shown to the subjects.

(7) *Big 5*

The Big 5 were measured on a 10-item scale (BFI-10, cf., Rammstedt et al. 2012). They read as follows: extraversion (energetic, enjoys meeting new people vs. reserved, prefers solitude), agreeableness (empathic, friendly vs. uninterested in others, challenging), conscientiousness (organized, finishes important things instantly vs. careless, procrastinates important things), neuroticism / emotional stability (anxious, easily upset vs. relaxed, emotionally stable), and openness to experience (open for new things, creative vs. dislike change, limited imaginative).

(8) *Sociodemographic and socioeconomic determinants*

A number of sociodemographic and socioeconomic variables were collected (e.g. gender, age, political attitude, activity in social networks, trust in mass media, and membership of a religious community).

(9) *Information about correctness of the stories*

At the very end of experiment 1, subjects were randomly assigned to one of five scenarios. All contain information of whether the stories were true or false. However, the scenarios differ in the manner of communication as well as in the amount of information provided to the subjects:

- Scenario 1: No information provided
- Scenario 2: Subjects were shown only the false news stories again (“The following news stories contain any kind of false news information.”)
- Scenario 3: Subjects were shown only the correct news stories again (“The following news stories are correct.”).
- Scenario 4: Subjects were communicated details about the false news stories (i.e., what was wrong & reasons for its dissemination).

For example, news story 1, consequences of climate change: “For logical reasons it is not possible that the probability of two events x_1 and x_2 together is greater than the probability of a single event

x2. [...] It is not possible that two consequences of climate change together are more likely than just one consequence.”⁴

- Scenario 5: Subjects were shown all stories again and provided with information on whether the stories are correct or contain any kind of false news information *and* (as a consequence) whether the answers of the subjects are correct or not (“This news story is correct / not correct. Your answer was correct / wrong.”)

3.2 Experiment 2 (Follow-up session 3 weeks later)

Three weeks after the first experiment, subjects were invited to join the second experiment. The only task in experiment 2 was to again rate the correctness of the 12 news stories as true or false. Note that in experiment 1 a total of 300 subjects were recruited. This means that $N=60$ subjects were randomly assigned to each of the scenarios. Since the subjects’ willingness to attend the second experiment was unclear *ex-ante*, I hoped that at least 50% of the subjects would also participate in the second experiment, which would result in a somewhat acceptable sample size of $N=30$ per scenario.

4 Approach to data analysis

(i) Primary outcome variable

The primary outcome variable is the correct identification of a story. Correct identification means that true stories are declared as true and false stories are declared as false. The analysis of experiment 1 comprises on the aggregate level the total number of stories that are correctly identified ($N = 0, \dots, 12$). I also consider the ability to identify false news stories and correct news stories, respectively ($N = 0, \dots, 6$). Moreover, the ability to correctly distinguish between true and false on the story-by-story level follows ($N = 0, 1$). Experiment 2 explores the efficiency of several treatments. The analysis is conducted on the aggregate level due to constraints in the sample size.

(ii) Methods

Ad experiment 1: Story-by-story analyses are carried out by using binary logistic regression models. Since the coefficients of logistic regression models cannot be interpreted in a meaningful way, average marginal effects are reported. At the aggregated level, simple OLS regressions are estimated. They are much easier to interpret than, for example, ordered logit models.

Ad experiment 2: In experiment 2, the subjects are shown the same news stories as in experiment 1. To deal with repeated measurements, I use the Wilcoxon matched-pairs signed-ranks test to test for equality of matched pairs of observations. The null hypothesis of the nonparametric test is that both distributions are the same.

(iii) Study type

With regard to the variables CRT and AOT, *ex-ante* hypotheses are formulated (i.e., both are positively correlated with the ability to distinguish between true and false). However, the bulk of the study is exploratory, i.e., the aim is to uncover patterns in the data. These can be analyzed in follow-up studies with new data in a so-called confirmatory analysis.

(iv) Data manipulation

⁴ See Appendix B for further details.

The question “Have you seen or heard about this story before?” could either be answered with “yes,” “uncertain” or “no.” To make data analysis simpler, I combined the answers “uncertain” and “no.” This approach is in line with the more recent literature (e.g. Pennycook et al. 2018).

Table 4. Summary of variables and their measurement

Variable	Question / Statement / → Explanation	Values	Comment
<i>Dependent variable</i>			
Correct identification story	If the story is accurate: identical to “Identification story” If story is false: reverse to “Identification story” (i.e., 1-“Identification story”)	1=yes; 0=no	
Identification story	What do you think of the content of this story? Is the claim made accurate?	1=yes; 0=no	After each story
-Identification story_false news -Identification story_correct news	Identical to “Identification story,” but considering only false news stories (Identification story_false news) or only correct news stories (Identification story_correct news)	1=yes; 0=no	Subset of stories
<i>Independent variables</i>			
Age	How old are you?	#Years	
AOT	Please rate your agreement or disagreement with each statement. 1. Allowing oneself to be convinced by an opposing argument is a sign of good character. 2. People should take into consideration evidence that goes against their beliefs. 3. People should revise their beliefs in response to new information or evidence. 4. Changing your mind is a sign of weakness. 5. Intuition is the best guide in making decisions. 6. It is important to persevere in your beliefs even when evidence is brought to bear against them. 7. One should disregard evidence that conflicts with one’s established beliefs.	1 = Completely Disagree, 7 = Completely Agree	Last 4 items reverse coded
Big 5	How well do the following statements describe your personality? I see myself as someone who... (1) ...is reserved, (2) ...is generally trusting, (3) ...tends to be lazy, (4) ...is relaxed, handles stress well, (5) ...has few artistic interests, (6) ...is outgoing, sociable, (7) ...tends to find fault with others, (8) ...does a thorough job, (9) ...gets nervous easily, (10) ...has an active imagination	(1) Disagree strongly, (5) Agree strongly [[Items 1, 3, 4, 5, and 7 recoded (1=5) (2=4) (3=3) (4=2) (5=1)]] Mean (3r,8) = Conscientiousness Mean (2,7r) = Agreeableness Mean (5r,10) = Openness Mean(1r,6) = Extraversion Mean (4r,9) = Neuroticism	
Challenges environment (friends)	I discuss environmental challenges with my friends...	Daily (6), several times a week(5), once a week (4), ..., less frequently (1)	
Competence (context)	Please assess yourself. How well are you informed about the following matters? 1. Consequences of climate change, 2. Microplastics, 3. Bee deaths, 4. Food waste, 5. Bird deaths, 6. Food contamination due to the consequences of Chernobyl, 7. Air pollution, 8. Nutrition of the world population, 9. Use of coffee paper cups, 10. Use of airplane for passenger transport, 11. Waste exports, 12. Smoking	Very poor (1), very well (5)	
Competence environment	How familiar are you with environmental issues?	Very good (5), very poor (1)	

CRT	<ol style="list-style-type: none"> 1) If it takes 2 nurses 2 minutes to measure the blood pressure of 2 patients, how long would it take 200 nurses to measure the blood pressure of 200 patients? 2) Soup and salad cost €5.50 in total. The soup costs a euro more than the salad. How much does the salad cost? 3) In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? 4) If you're running a race and you pass the person in second place, what place are you in? 5) A farmer had 15 sheep and all but 8 died. How many are left? 6) Emily's father has three daughters. The first two are named April and May. What is the third daughter's name? 7) How many cubic feet of waste are there in an empty box that is 10 cm wide 20 cm deep 10 cm long? 	<p>CRT-Score = number of correct answers to the questions:</p> <ol style="list-style-type: none"> 1) 2 2) 2.25 3) 47 4) 2 5) 8 6) Emily 7) 0 	
Degree program	<p>How would you categorize your field of study in terms of content?</p> <p>(Social Sciences, Law, Economics, Humanities and Cultural Studies, Art and Design, Medicine and Health Care, Agricultural and Forestry Sciences, Mathematics and Natural Sciences, Engineering, Other)</p>		
Discourse (value-loaded)	<p>How would you best describe the public discourse on environmental issues? Please choose an alternative.</p>	<p>Value-loaded, no free exchange of perspectives (=1);</p> <p>Objective discourse, open exchange of perspectives (=0)</p>	
Female (=1)	<p>What is your gender?</p>	<p>Female = 1, Male = 0 (Other=2)</p>	<p>"Other" dropped due to low sample size (N=2)</p>
Overconfidence environment	<p>My knowledge of environmental issues is [...] than that of an average student at the Martin Luther University Halle-Wittenberg.</p>	<p>Much worse (5), much better (1)</p>	
Politics (right)	<p>In politics people often talk about "left" and "right" to distinguish different attitudes. If you think about your own political views: Where would you place them?</p>	<p>0=entirely left, 10=entirely right</p>	
Religion	<p>Do you belong to a church or religious group?</p>	<p>1=yes; 0=no</p>	
Risk attitude	<p>→ Procedure according to Eckel and Grossman → Subjects had to pick one out of six gambles (which determines the individual risk attitude)</p>	<p>1-4=Risk averse 5=Risk neutral 6=Risk seeking</p>	
Risk society (context)	<p>How do you assess the risks/hazards to the environment and society of the following issues?</p> <p>1. Consequences of climate change, 2. Microplastics, 3. Bee deaths, 4. Food waste, 5. Bird deaths, 6. Food contamination due to the consequences of Chernobyl, 7. Air pollution, 8. Nutrition of the world population, 9. Use of coffee paper cups, 10. Use of airplane for passenger transport, 11. Waste exports, 12. Smoking</p>	<p>Very small (1), very large (5)</p>	
Social networks	<p>Do you have an account on social networks such as Facebook or Twitter?</p>	<p>Yes, I actively use it (4), Yes, I use it occasionally (3), Yes, but I don't use it (2), No (1)</p>	
Story seen	<p>Have you seen or heard this news story before?</p>	<p>yes=1, no/unsure=0</p>	<p>After each story</p>
-Story seen_false news -Story seen_correct news	<p>Identical to "Story seen," but only considers false news stories (Story seen_false news) or only correct news stories (Story seen_correct news)</p>	<p>yes=1, no/unsure=0</p>	<p>Subset of stories</p>
Trust mass media	<p>In general, how much trust and confidence to you have in the mass media - such as newspapers, TV, and radio - when it comes to reporting the news fully, accurately, and fairly?</p>	<p>Very low (1), very high (5)</p>	<p>Source: Gallup news (2010)</p>

5 Description of the subjects

A total of 300 subjects were recruited (see Table 5). Among them, 173 were women, 125 men, and 2 subjects identified themselves with the third sex. The subjects are on average 22.5 years old (women are slightly younger). Men have a higher score in both AOT and CRT. On average, women ($M=2.5$) are more risk-averse than men ($M=3.5$). Higher mean values can be found in the Big 5 for women, although the difference is relatively small for extraversion. Men indicate to be politically slightly more right than women on average. Moreover, the proportion of subjects belonging to a religious community is higher for men than for women. On average, trust in mass media is about the same between women and men. Women report a somewhat higher level of activity in social networks. The majority of subjects assess the discourse in the environmental field as value-loaded. This is somewhat more pronounced with men. On average, men indicate that they are more frequently discussing environmental issues with others, rate their competence in environmental issues more highly, and more often claim to be better than the average student. An interesting difference between men and women can be seen in the variable risk society (context): on average, women indicate in all 12 contexts that they are more worried about the respective risks for the environment and society than men (Risk society (context), see Appendix D). The self-assessment of one's own competence among the different contexts is not always the same between the sexes, but there seem to be no systematic differences (Competence (context), see Appendix D).

Table 5. Description of the subjects (N=300)

Variable	Overall	Female	Male
Age	22.46 (3.47)	21.98 (3.12)	23.06 (3.82)
AOT	5.49 (0.77)	5.34 (0.73)	5.69 (0.80)
CRT	5.79 (1.43)	5.67 (1.32)	5.96 (1.54)
Risk attitude	2.96 (1.58)	2.54 (1.37)	3.55 (1.69)
Conscientiousness	3.49 (0.84)	3.61 (0.82)	3.34 (0.86)
Agreeableness	2.98 (0.79)	3.16 (0.73)	2.72 (0.81)
Openness	3.50 (0.99)	3.60 (0.99)	3.34 (0.97)
Extraversion	3.13 (1.00)	3.18 (0.99)	3.04 (1.02)
Neuroticism	3.04 (0.95)	3.24 (0.91)	2.74 (0.94)
Politics (right)	3.53 (1.83)	3.33 (1.60)	3.84 (2.08)
Religion	0.29	0.27	0.32
Trust mass media	3.05 (0.86)	3.02 (0.75)	3.08 (1.01)
Social networks	3.09 (0.98)	3.22 (0.87)	2.90 (1.09)
Discourse (value-loaded)	0.68	0.63	0.73
Challenges environment (friends)	3.13 (0.92)	3.06 (0.92)	3.23 (0.92)
Competence environment	3.28 (0.69)	3.19 (0.65)	3.40 (0.71)
Overconfidence environment	3.19 (0.70)	3.10 (0.65)	3.30 (0.76)

6 Experimental results

The experimental subjects were recruited via the learning platform of the Martin Luther University Halle-Wittenberg (StudIP). In StudIP, people were advertised on the bulletin board and in various bachelor courses (with different degree programs). Experiment 1 lasted from 2019-12-17 to 2019-12-23. Each subject was contacted again 3 weeks later. Experiment 2 began on 2020-01-07 and data collection was closed on 2020-01-20.

5.1 Experiment 1

6.1.1 Overall ability to distinguish between true and false news stories

On average, the subjects correctly identified slightly more than half of the news stories ($M=6.69$). Male subjects ($M=7.04$) were on average slightly more successful than female subjects ($M=6.45$) in distinguishing between true and false. What determinants can explain the ability to distinguish between false and true? For this purpose, we run a simple OLS regression, with the number of stories which are correctly identified as dependent variable (cf., Table 6). Three specifications are reported, which differ in terms of gender.⁵ The results of the regressions indicate that the perceived familiarity with the stories is crucial for the subjects' evaluation. Familiarity increases the respondents' propensity to accept stories as true. This leads to an increase in correct identification for true news stories (Story seen_correct news) and a reduction in correct identification for false news stories (Story seen_false news). The effect of "Story seen_false news" seems to be more pronounced for men than for women. The opposite is the case for the effect of "Story seen_correct news." Moreover, we find a positive relationship between AOT score and the ability to distinguish between false and true. This is in line with previous studies on false news stories. However, this association can be found in particular for men (panel III), while it is negligible for women (panel II). The results of CRT are somewhat surprising since the sign is negative. This is in contrast to previous studies. However, the p-values are relatively high and the magnitude of the coefficient is relatively low. As indicated above, the results indicate that women might perform worse in distinguishing between true and false news in this study. Further research is necessary since the p-value is high. There also seem to be gender differences in social network activities: the more activity, the worse women perform in distinguishing between true and false (panel II); the opposite holds for men (panel III), but the effect size is very small and the p-value relatively high.

⁵ I would like to thank Jeff Hancock (Stanford University), who drew my attention to the relatively unexplored relation between false news stories and the role of gender.

Table 6. Regressions to explain the adequate identification of all 12 stories (OLS)

	I All subjects (N=298)		II Female subjects (N=173)		III Male subjects (N=125)	
	Coef (SE)	P-Value	Coef (SE)	P-Value	Coef (SE)	P-Value
Story seen_false news	-0.3651 (0.0743)	0.000	-0.3112 (0.0998)	0.002	-0.4141 (0.1282)	0.002
Story seen_correct news	0.2355 (0.0666)	0.000	0.2690 (0.0929)	0.004	0.1962 (0.1060)	0.067
AOT	0.2585 (0.1202)	0.032	0.1468 (0.1632)	0.370	0.4168 (0.1981)	0.038
CRT	-0.0664 (0.0643)	0.302	-0.0798 (0.0872)	0.362	-0.1196 (0.1051)	0.258
Female (=1)	-0.2366 (0.2060)	0.252	-		-	
Conscientiousness	0.0231 (0.1075)	0.829	0.1023 (0.1461)	0.485	-0.0114 (0.1710)	0.947
Agreeableness	-0.1822 (0.1184)	0.125	-0.0979 (0.1615)	0.545	-0.1730 (0.1784)	0.335
Openness	-0.0110 (0.0910)	0.904	-0.0529 (0.1168)	0.651	0.1021 (0.1537)	0.508
Extraversion	0.0395 (0.0976)	0.686	0.0214 (0.1301)	0.870	0.1159 (0.1546)	0.455
Neuroticism	-0.0401 (0.0980)	0.682	0.0383 (0.1338)	0.775	-0.1121 (0.1567)	0.476
Religion	0.1304 (0.2006)	0.516	0.0088 (0.2757)	0.975	0.2428 (0.3186)	0.448
Trust mass media	0.0418 (0.1049)	0.690	0.3136 (0.1579)	0.049	-0.0907 (0.1450)	0.533
Social networks	-0.1637 (0.0928)	0.079	-0.4358 (0.1364)	0.002	0.0892 (0.1320)	0.501
Politics (right)	-0.0642 (0.0537)	0.233	-0.0692 (0.0788)	0.381	-0.0370 (0.0771)	0.632
Age	0.0405 (0.0267)	0.130	0.0650 (0.0379)	0.089	0.0387 (0.0394)	0.328
Discourse (value-loaded)	0.0684 (0.1904)	0.720	-0.1267 (0.2437)	0.604	0.5118 (0.3210)	0.114
Challenges environment (friends)	0.0530 (0.1091)	0.627	0.1280 (0.1416)	0.367	-0.0393 (0.1812)	0.828
Overconfidence environment	0.0533 (0.1520)	0.726	0.1875 (0.2189)	0.393	0.0168 (0.2237)	0.940
Competence (context)	0.1391 (0.1583)	0.380	0.1772 (0.2203)	0.422	-0.0817 (0.2409)	0.735
Risk attitude	0.0163 (0.0600)	0.786	0.1011 (0.0897)	0.261	-0.0732 (0.0833)	0.382
	Prob > F	0.0000	0.0010		0.1022	
		F(20, 277) = 3.16	F(19, 153) = 2.53		F(19, 105) = 1.50	
	Adjusted R-squared	0.1270	0.1442		0.0705	

6.1.2 Ability to adequately identify correct as well as false news stories

In this section, we put emphasis on whether there are differences between the adequate identification of correct news stories on the one hand and false news stories on the other one. The majority of correct news stories are identified as such (M=4.58), with slightly higher mean values for men (M=4.76) than for women (M=4.44). The subjects performed much worse in correctly identifying false news (M=2.11). Similar to the identification of correct new stories, on average men (M=2.28) performed slightly better than women (M=2.00). These initial results indicate that people are relatively uncritical to news stories (i.e., they tend to trust both true and false news stories). In the following, we want to address several determinants to explain the ability to distinguish between true and false with the help of regression analysis (cf., Table 7).

As indicated above, perceived familiarity with the stories is crucial: it increases the correct identification of correct news and decreases the correct identification of false news. AOT seems to be important, but only

for the identification of correct news stories (in particular for men, panel III). However, AOT appears to be negligible in identifying false news stories. Therefore, AOT has only limited potential to protect against false news stories. Panels I and IV indicate that the influence of CRT over all subjects is not only very small but also negative. Within the study, women perform slightly worse in terms of identifying correct as well as false news stories (panels I and IV). The p-value is quite high for gender. Thus, further research is necessary to find out whether there are gender-specific differences in distinguishing between true and false news stories. The relevance of activity in social networks seems to be similar for the identification of correct and false news stories: for women, there is a negative, noteworthy effect; whereas for men, there is a positive, but economically negligible correlation. There are at least two more interesting variables in the regressions: extraversion and trust in the mass media. Extraversion seems to counteract the familiarity effect, i.e., it is negatively correlated with the ability to adequately identify correct news stories; but positively correlated with the ability to correctly detect false news stories. The more subjects trust in the mass media, the greater is their success in adequately identifying correct and false news for women (panels II and V); for men, the opposite applies, but the effect size is small (regressions III and VI).

Table 7. Regressions to explain the adequate identification of correct and false news (OLS)

		Adequate identification of correct news						Adequate identification of false news					
		I All		II Female		III Male		IV All		V Female		VI Male	
		Coef (SE)	P- Value	Coef (SE)	P- Value	Coef (SE)	P- Value	Coef (SE)	P- Value	Coef (SE)	P- Value	Coef (SE)	P- Value
	Story seen	0.1886 (0.0402)	0.000	0.2278 (0.0570)	0.000	0.1740 (0.0591)	0.004	-0.3238 (0.0477)	0.000	-0.3172 (0.0649)	0.000	-0.3573 (0.0775)	0.000
	AOT	0.2351 (0.0859)	0.007	0.0932 (0.1184)	0.432	0.3543 (0.1386)	0.012	0.0297 (0.0912)	0.745	0.0675 (0.1238)	0.586	0.0700 (0.1507)	0.643
	CRT	-0.0183 (0.0460)	0.690	-0.1034 (0.0633)	0.104	0.0146 (0.0734)	0.843	-0.0493 (0.0489)	0.314	0.0233 (0.0671)	0.729	-0.1385 (0.0796)	0.085
	Female (=1)	-0.1050 (0.1474)	0.477	-		-		-0.1309 (0.1567)	0.404	-		-	
	Conscientiousness	0.0107 (0.0770)	0.889	0.0995 (0.1060)	0.349	-0.0315 (0.1195)	0.793	0.0148 (0.0818)	0.856	0.0121 (0.1115)	0.913	0.0140 (0.1294)	0.914
	Agreeableness	-0.0352 (0.0847)	0.678	0.0817 (0.1173)	0.487	-0.1039 (0.1252)	0.409	-0.1432 (0.0899)	0.112	-0.1752 (0.1243)	0.161	-0.0705 (0.1351)	0.603
	Openness	0.0057 (0.0651)	0.929	-0.0936 (0.0847)	0.271	0.1755 (0.1065)	0.102	-0.0157 (0.0692)	0.820	0.0448 (0.0895)	0.617	-0.0833 (0.1155)	0.472
	Extraversion	-0.1753 (0.0690)	0.012	-0.2111 (0.0935)	0.025	-0.1280 (0.1072)	0.235	0.2067 (0.0740)	0.006	0.2344 (0.0999)	0.020	0.2332 (0.1173)	0.049
	Neuroticism	-0.0936 (0.0697)	0.181	-0.1137 (0.0971)	0.244	-0.0226 (0.1074)	0.834	0.0491 (0.0745)	0.510	0.1566 (0.1029)	0.130	-0.1044 (0.1183)	0.379
	Religion	0.0618 (0.1432)	0.666	0.1203 (0.1925)	0.533	-0.0912 (0.2178)	0.676	0.0945 (0.1497)	0.528	-0.0909 (0.2033)	0.655	0.2976 (0.2424)	0.222
	Trust mass media	0.0390 (0.0751)	0.603	0.2010 (0.1147)	0.082	-0.0207 (0.1018)	0.839	0.0014 (0.0798)	0.985	0.1112 (0.1215)	0.362	-0.0698 (0.1103)	0.528
	Social networks	-0.0954 (0.0664)	0.152	-0.2027 (0.0990)	0.042	0.0213 (0.0925)	0.818	-0.0680 (0.0706)	0.336	-0.2294 (0.1047)	0.030	0.0713 (0.1004)	0.479
	Politics (right)	-0.0578 (0.0384)	0.133	-0.0537 (0.0569)	0.347	-0.0400 (0.0534)	0.455	-0.0064 (0.0408)	0.874	-0.0129 (0.0602)	0.831	-0.0024 (0.0582)	0.967
	Age	0.0186 (0.0190)	0.328	0.0426 (0.0273)	0.121	0.0030 (0.0274)	0.913	0.0251 (0.0200)	0.212	0.0246 (0.0287)	0.392	0.0373 (0.0294)	0.207
	Discourse (value-loaded)	0.0689 (0.1360)	0.613	0.0062 (0.1771)	0.972	0.1544 (0.2219)	0.488	0.0102 (0.1445)	0.944	-0.1315 (0.1876)	0.484	0.3803 (0.2411)	0.118
	Challenges environment (friends)	0.1497 (0.0780)	0.056	0.2369 (0.1026)	0.022	0.0462 (0.1271)	0.717	-0.0997 (0.0830)	0.231	-0.1150 (0.1083)	0.290	-0.0887 (0.1371)	0.519
	Overconfidence environment	-0.0604 (0.1088)	0.579	0.0650 (0.1588)	0.683	-0.1001 (0.1565)	0.524	0.1163 (0.1156)	0.315	0.1404 (0.1663)	0.400	0.1099 (0.1698)	0.519
	Competence (context)	0.1518 (0.1133)	0.181	0.0850 (0.1601)	0.596	0.1127 (0.1682)	0.504	-0.0044 (0.1202)	0.970	0.1051 (0.1689)	0.535	-0.1837 (0.1828)	0.317
	Risk attitude	-0.0478 (0.0430)	0.267	-0.0050 (0.0551)	0.938	-0.0749 (0.0585)	0.203	0.0636 (0.0457)	0.165	0.1088 (0.0688)	0.116	0.0027 (0.0634)	0.965
	Prob > F	0.0000 F(19, 278) = 3.56		0.0002 F(18, 154) = 2.93		0.0396 F(18, 106) = 1.76		0.0000 F(19, 278) = 3.64		0.0029 F(18, 154) = 2.33		0.0033 F(18, 106) = 2.38	
	Adjusted R- squared	0.1409		0.1681		0.0997		0.1445		0.1218		0.1665	

6.1.3 Story-specific ability to distinguish between true and false

We now want to highlight some differences in the correct identification between the various news stories.⁶ In Table 8, the fraction of subjects that correctly identified the respective stories is depicted. There are considerable differences: it ranges from very low (e.g. #10 or #1) to very high fractions (e.g. #9 or #4).

⁶ In addition, logit regressions were carried out to explain the ability to correctly identify the stories as correct or false, mainly as a robustness check of the aggregated results (cf., Appendix C). The core results from the aggregated (OLS) regressions above can also be found here. For example, having seen or heard about the respective stories (seemingly) increases the ability to correctly identify correct news stories and decreases the ability to correctly identify correct news stories—this stands in contrast to extraversion. Furthermore, CRT is rather small or even negative. In most regressions, AOT is positively related to distinguishing between true and false. Gender deviates among the regressions, but women seem to perform slightly worse than men.

How can it be that for some stories 15% or less of the respondents gave the correct answer, while for other stories more than 90% of the subjects identified the story correctly?

Table 8. Story-by-story identification: a first glance (N=300)^(a)

#	Label of Stories	Correct or false	Correct identification (in %)		
			Overall N=300	Female (=1) N=173	Male (=0) N=125
1	Consequences of climate change	False	15.00	13.87	16.80
2	Microplastics	Correct	65.67	65.32	65.60
3	Importance of the honey bee	False	29.00	22.54	38.40
4	Food waste	Correct	94.00	93.64	94.40
5	Causes of bird deaths	False	75.33	72.25	79.20
6	Mushrooms and consequences of Chernobyl	Correct	71.33	65.90	79.20
7	Air quality	Correct	57.00	52.60	62.40
8	Nutrition of the world population	False	29.00	28.90	29.60
9	Use of coffee paper cups	Correct	91.33	90.17	92.80
10	Use of airplane for passenger transport	False	13.33	12.72	14.40
11	Waste exports	Correct	79.00	76.88	82.40
12	Smoking	False	49.67	50.29	49.60

(a) For correct news stories applies: percentage of subjects believing that the story is correct = correct identification; for incorrect news stories the percentage of correct identification is 100% minus the percentage of subjects believing that the story is correct.

Story 1 describes the consequences of climate change with the help of a conjunction fallacy. According to this, two consequences together are more likely to happen in the course of climate change than just one of the consequences. From a logical point of view this is wrong. But it is representative: currently, there are many Fridays for Future demonstrations in Germany, and the local university, where this study has been carried out, is also actively involved. Therefore, it is not surprising that people perform poorly here. People do not think in equations, they have a story in their mind with the consequences of climate change. Another subject in which widely distributed narratives⁷ may be play an important role is news story 10: The reputation of politicians is limited since examples seem to be easily available (i.e., representativeness heuristic) where politicians broke rules or renege on promises. Since subjects are caught in a venue of narratives, making things more extreme does not violate the picture in their heads (i.e., the story itself), and, in turn, will be accepted relatively uncritically. Subjects' performance is poor because they think the stories

⁷ An insightful book on narratives in economics has recently been published by Shiller (2019).

are typical for reality. Relatedly, the stories 4 and 9 tackle other narratives. Subjects seem to be quite aware that food waste is a serious threat to society as well as paper cups are. So, the only difference to other news stories, such as #10 or #1, is that no manipulation was implemented. Making things more extreme would result in a false news story, but would probably not be correctly identified by the subjects.

6.2 Experiment 2 (3-Week Interval)

The subjects were given information about the correctness of the stories at the end of experiment 1. The five scenarios are: scenario 1 (no information), scenario 2 (communication of the stories which contain false new information), scenario 3 (communication of the stories which are correct), scenario 4 (communication of details), and scenario 5 (story-by-story identification). Three weeks after experiment 1, the subjects were shown the news stories again. Of the 300 subjects in experiment 1, a total of 240 subjects also joined experiment 2.⁸ The findings are shown in Table 9.

Overall, the scenarios led to a slight increase in the ability to distinguish between false and correct news content on average (+0.1625). However, the effect is not statistically significant (p-value = 0.1153). There are considerable differences between the scenarios. The scenarios 1 and 2 performed worst. Both scenarios 1 and 2 have a detrimental effect on the correct differentiation between false and correct news stories (but neither of them is statistically significant; p-values: 0.1989 and 0.4877, respectively). Scenario 5 produced a small (+0.056604), but not statistically significant effect (p-value = 0.7297). Scenarios 3 and 4 positively affected the ability to distinguish between false and correct news stories. Besides notable effect magnitudes (+0.489362 and +0.644445, respectively), the effects are statistically significant at the 5% level (0.0258 and 0.0187). To put it differently, repeating the correct stories or providing subjects with details and explanations of why stories are wrong seems to be beneficial.

By repeating false news stories, subjects are more likely to adequately identify them later (+1.212766; p-value = 0.0000). Thus, there is no evidence for a familiarity backfire effect. However, repeating false news stories results in a decreased ability to adequately identify correct messages (-1.340426; p-value = 0.0000). A somewhat reverse, but weaker effect seems to occur when correct stories are repeated: the adequate identification of correct news stories is more successful (+0.617021, p-value = 0.0013), but the opposite holds for the identification of false news stories (-0.12766, p-value = 0.5414). Detailed explanations why the false stories contain false content (scenario 4) increases the correct identification of false news stories (+1.4, p-value = 0.0000), but the effect on the correct identification of correct news stories is detrimental (-0.755556, p-value = 0.0005). In scenario 5, where each story is uncovered and the participants are explicitly told whether they were right or wrong, results are ambiguous: subjects perform better in adequately identifying false stories (+0.528301, p-value = 0.0400), but perform worse in adequately identifying correct messages (-0.471698, p-value = 0.0213). This indicates that the subjects might be more interested in which messages are wrong.

⁸ The number of subjects in experiment 2 is distributed among the scenarios as follows: scenario 1 (N = 48), scenario 2 (N = 47), scenario 3 (N = 47), scenario 4 (N = 45), and scenario 5 (N = 53). The reduced sample size can at least in part be explained by the fact that subjects provided email addresses with typos or the invitation to the second experiment landed in their spam order (as one subject pointed out later).

Table 9. Efficacy of the scenarios

Scenarios	$\Sigma 1-5$	1	2	3	4	5
		No information	False news stories shown	Correct news stories shown	Details on false news stories	Story-by-Story identification
I Correct identification overall						
Mean Experiment 1	6.775	6.895833	7.042553	6.468085	6.844444	6.641509
Mean Experiment 2	6.9375	6.6875	6.914894	6.957447	7.488889	6.698113
Difference	+0.1625	-0.208333	-0.127659	+0.489362	+0.644445	+0.056604
P-value	0.1153	0.1989	0.4877	0.0258	0.0187	0.7297
II Correct identification of false news stories						
Mean Experiment 1	2.15	2.145833	2.234043	2.212766	2.044444	2.113208
Mean Experiment 2	2.7	1.9375	3.446809	2.085106	3.444444	2.641509
Difference	+0.55	-0.208333	+1.212766	-0.12766	+1.4	+0.528301
P-value	0.0000	0.1452	0.0000	0.5414	0.0000	0.0400
III Correct identification of correct news stories						
Mean Experiment 1	4.625	4.75	4.808511	4.255319	4.8	4.528302
Mean Experiment 2	4.2375	4.75	3.468085	4.87234	4.044444	4.056604
Difference	-0.3875	+/- 0	-1.340426	+0.617021	-0.755556	-0.471698
P-value	0.0003	0.9182	0.0000	0.0013	0.0005	0.0213

7 Conclusions and further research

The purpose of this paper was twofold: first, to find out who is good at identifying false news stories, and second, to learn something about how to debunk false news stories. For this purpose, an experimental study

was carried out, which tackled environmentally-related news stories. A key result of this study is related to the familiarity with the stories. While Pennycook et al. (2018) use the title “Prior Exposure Increases Perceived Accuracy of Fake News” in one of their works, our study provides evidence that even the *perceived* familiarity with the stories is crucial for the subjects’ propensity to accept the stories as true. Many participants stated familiarity with the stories, even if it contained fabricated news. It is conceivable that familiarity is perceived when news stories are in line with own beliefs (confirmation bias) or narratives. Former studies in the area of false news found a positive correlation between AOT and CRT and the ability to distinguish between false and true. Our study finds no effect or even an adverse effect for CRT. But AOT is in line with existing experimental findings. If the latter is robust, human capacity building might help to strengthen subjects’ ability to stronger revise beliefs and the search for alternative explanations. Another but surprising result is that women were slightly worse at distinguishing between true and false.

Correcting false news stories is a challenge. Within this study, we tried out the efficiency of several measures. By repeating false news stories, subjects were more likely to adequately identify them later. Thus, there is no evidence for a familiarity backfire effect. However, repeating false news stories resulted in a decreased ability to adequately identify correct messages. A somewhat reverse, but weaker effect seems to occur when true stories are repeated: the correct identification of correct news stories is more successful, but the opposite holds for the identification of false news stories. Detailed explanations of why the false stories contain false content increases the correct identification of false news stories, but the effect on the correct identification of correct news stories is detrimental. This evidence indicates that fact-checking is barely enough but must be combined with other measures such as regulation, artificial intelligence, and market-based approaches. This is left open for future research.

This study suffers from some limitations which serve as a starting point for further research. First of all, it is a small, ad hoc sample of students who have self-selected themselves into the study. Therefore, we cannot claim any representativeness of the findings neither for students nor for the population in Germany. The results should rather be interpreted as a starting point for further research. In the study, decisions were explicitly requested. Thus, the subjects were forced to actively think about the news stories. In everyday life (especially in leisure time) people may be less critical. Especially in study situations, participants may want to present themselves as critical-thinking individuals and, in case of doubt, tend to indicate that a report would be wrong and not correct. Furthermore, the paper cannot capture the complexity of social networks. This includes comments from relevant others or activities of friends.

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Appendix A: Translated news stories and further information

The following news items have been used in the study. For each story the source is provided where the story has been taken from. For fabricated news items, I provide some details about the false content.

1. Consequences of climate change

Climate change has consequences for all regions of the world. The ice of the polar caps is melting and sea levels are rising. In some regions, extreme weather events and increasing precipitation are becoming more frequent, while elsewhere extreme heat waves and droughts are intensifying. Water expands when it warms. At the same time, the polar ice caps and glaciers are melting as a result of global warming. *These changes are more likely to cause both sea-level rise and erosion in coastal areas than sea-level rise alone.*

- Source of the news item (not shown to the subjects):
https://ec.europa.eu/clima/change/consequences_de
- Part in italics is fabricated content and not part of the original story
(Subjects were shown the sentences but not highlighted in italics)

2. Microplastics

A study found that around 330,000 tons of so-called microplastics are released into the environment in Germany every year. The Fraunhofer Institute for Environmental, Safety and Energy Technology in Oberhausen has calculated the quantities that are released by 51 sources. Pedestrians also release microplastics into the environment via the soles of their shoes. It is estimated that around one hundred grams are released per capita and year in Germany. That puts footwear in the seventh place on the list of the largest microplastic sources in the study. With 19 grams, shampoos and co. are in 17th place on the negative list.

- Source of the news item (not shown to the subjects):
<https://www.spiegel.de/wissenschaft/mensch/mikroplastik-der-groesste-verursacher-sind-autoreifen-a-1226400.html>

3. Importance of the honey bee

The honey bee plays a major role in the conservation of biodiversity and the fruit yield of many vegetable, fruit, and arable crops. Professor Thomas D. Seeley, author of “The Lives of Bees: The Untold Story of the Honey Bee in the Wild” and Horace White Professor at Cornell University, described the importance of the bee as follows: “Once the bee disappears from the earth, mankind has only four years to live. No more bees, no more pollination, no more plants, no more animals, no more humans.”

- Source of the news item (not shown to the subjects): Various sources, for example, <https://www.salonkolumnisten.com/mythenjagd-10-bienensterben/> (quotation wrongly attributed to Albert Einstein)
falschzitate.blogspot.com/2017/05/wenn-die-biene-einmal-von-der-erde.html
- The very beginning is true (relevance of the honey bee), the person really exists (and yes, it is a famous researcher within the field of honey bees), but neither Albert Einstein nor Thomas Seeley have ever pointed out this quotation.

4. Food waste

Each year, about one third of the world’s food gets lost on its way from the field to the plate, while at the same time about 800 million people suffer from hunger. What’s more, waste is a burden on the environment. More than 38 million tons of greenhouse gases are produced annually, about 43,000 square kilometers of agricultural land are used, and 216 million cubic meters of water are consumed. Moreover, for every foodstuff we eat, energy is consumed in production and transport, and we also use pesticides, mineral and agricultural fertilizers that pollute the environment.

- Source of the news item (not shown to the subjects):
<https://www.umweltbundesamt.de/themen/wider-die-verschwendung>

5. Causes of bird deaths

Our birds fortunately belong to the best-studied groups of living organisms, and the data on their population and trends in population are excellent - compared to other groups of animals such as insects. Birds are therefore particularly suitable as indicators of the overall condition of nature. *What are the threats to the domestic bird population? Wind turbines cost some birds their lives. The animals get caught in the rotor blades or fly against masts. The German Nature and Biodiversity Conservation Union (Naturschutzbund Deutschland) estimates the number of bird deaths to be higher for power lines than for hunting. Furthermore, it states that hunting causes more victims than wind turbines. It is therefore not surprising that experts see the cause of bird deaths primarily in wind turbines rather than in power lines.*

- Source of the news item (not shown to the subjects):
<https://www.nabu.de/tiere-und-pflanzen/voegel/gefaehrdungen/24661.html>
- Part in italics is fabricated content and not part of the original story
(Subjects were shown the sentences but not in italics)

6. Mushrooms and consequences of Chernobyl

More than 30 years ago, the reactor in Chernobyl exploded. However, the consequences are still being felt not only there but also here in Germany. Some foodstuffs are still contaminated radioactively today. The radioactive cloud that swept across Europe in April and May 1986 contaminated large parts of Germany. The regions of Bavaria, southern Thuringia, and areas in Baden-Württemberg were particularly affected at the time. Even today, the soils in many regions, especially in southern Germany, and some foodstuffs are still contaminated with caesium-137 and, to a lesser extent, strontium-90. Some mushroom species, such as bread stubble fungi, chestnut boletuses, black-headed milkworts, trumpet chanterelles, and sweet-smelling snailblades, still exhibit a strongly increased radioactivity to some extent.

- Source of the news item (not shown to the subjects):
<https://www.verbraucherzentrale.de/wissen/lebensmittel/lebensmittelproduktion/tschernobyl-und-die-folgen-lebensmittel-immer-noch-belastet-12683>

7. Air quality

Despite improvements in air quality in Europe, persistent air pollution continues to cause hundreds of thousands of premature deaths on the continent each year. As the European Environment Agency (EEA) announced in Copenhagen, around 400,000 people died prematurely in 2016 in the EU because they were exposed to particulate matter. Nitrogen dioxide (NO₂) and ozone also led to premature deaths. Nearly all Europeans living in cities are exposed to air pollution that exceeds the recommended levels of the World Health Organization (WHO), the agency said in its annual report on air quality in Europe published today.

- Source of the news item (not shown to the subjects):
<https://www.aerzteblatt.de/nachrichten/106726/Umweltagentur-400-000-Todesfaelle-wegen-Luftverschmutzung-in-Europa>

8. Nutrition of the world population

An international research team under the supervision of Pete Smith, from the University of Aberdeen, published groundbreaking results on the nutrition of the world population in the renowned journal “Nature.” The authors discuss various strategies. They take a critical view of conventional agriculture: through the use of nitrogen fertilizers beyond what agricultural crops can absorb, groundwater is polluted and insects die due to chemical synthetic pesticides. *In contrast, the authors see opportunities in the complete conversion to organic farming in order to maintain today’s standards.*

- Source of the news item (not shown to the subjects):
<https://www.spiegel.de/wissenschaft/mensch/kann-oekologische-landwirtschaft-die-menschheit-ernaehren-a-1177968.html>
- Part in italics is fabricated content (the authors said the opposite) and not part of the original story (Subjects were shown the sentences but not in italics)

9. Use of coffee paper cups

On the way to work, during the lunch break, on the track: coffee to go is omnipresent - and with it the corresponding disposable cups. The German Environment Agency (UBA) calls the paper cups “cups in the hot drinks segment for out-of-home consumption” somewhat brittle, which are increasingly becoming a problem in cities. On Tuesday, the agency published a new study on the to-go cups. The result: the total volume of coffee cups in Germany in 2016 was about 2.8 billion; that corresponds to 34 cups per inhabitant. According to the study, six out of ten cups are plastic-coated paper cups, the remaining pure plastic cups. But that is not all: there are also 1.3 billion plastic lids. While the paper cups are sold by bakeries or cafés - usually with lids - the lidless, pure plastic cups usually come from vending machines in companies, for example.

- Source of the news item (not shown to the subjects):
<https://www.sueddeutsche.de/wirtschaft/to-go-becher-einweg-umwelt-nachhaltigkeit-1.4455834>

10. Use of airplane for passenger transport

117 million passengers departed from German airports in 2018 - a record. The government is now discussing measures to curb the popularity of flying. The only embarrassing thing is that politicians and government officials prefer to fly themselves. Politicians in the federal government and their civil servants do not have to pay for their official flights and trips. Yet they do not set a good example. The Federal Ministry of the Interior confirmed to the ARD magazine “Hart aber fair” not the exact numbers, but nevertheless the politicians’ preference for flying. *According to the magazine, government officials boarded an airplane more than forty times as often as they took the train: 2,661 train rides are offset by 109,422 flights.*

- Source of the news item (not shown to the subjects):
<https://www.br.de/nachrichten/deutschland-welt/thema-politikerfluege-zugfahren-predigen-ins-flugzeug-steigen,RcJmHo8>
- Part in italics is fabricated content and not part of the original story
(Subjects were shown the sentences but not in italics)

11. Waste exports

Germany's consumers are spending an extra one billion euros on complex packaging disposal - year after year. Used glass, paper, textiles or batteries are carefully separated from ordinary household waste, and discarded televisions or toasters often take miles to reach the municipal building yard. Now, however, a study by the University of Würzburg-Schweinfurt is questioning the image of the environmentally friendly waste separation nation: Calculated in tons, Germany exported significantly more waste abroad in 2018 than products of the mechanical engineering industry, the Würzburg Logistics Institute found out together with the software company AEB. Up to 20 percent of the plastic waste produced went abroad.

- Source of the news item (not shown to the subjects):
<https://www.handelsblatt.com/unternehmen/handel-konsumgueter/abfall-deutschland-exportiert-mehr-muell-als-maschinen/25078510.html?ticket%20%80%A6&ticket=ST-1902132-ZXMyusoaESjvpsvxWRxO-ap6>

12. Smoking

It is a growing trend among adolescents to refrain from using tobacco filters to be able to enjoy smoking for longer. Scientists from London and San Diego therefore call in the British Medical Journal for a *complete ban on cigarettes sold without filters. They argue that cigarettes with filters absorb part of the tar and thus allow "healthier" smoking. "Our studies provide clear evidence that this safety argument should be followed to mitigate the already harmful effects of smoking,"* write Thomas Novotny of San Diego State University and his colleagues from the London School of Hygiene & Tropical Medicine in their article.

- Source of the news item (not shown to the subjects):
<https://www.aerzteblatt.de/nachrichten/106976/Forscher-fordern-Verbot-von-Filterzigaretten>
- Part in italics is fabricated content (authors claim the opposite) and not part of the original story
(Subjects were shown the sentences but not in italics)

Appendix B: Translation of the details provided to the subjects in scenario 4

- **Consequences of climate change**

For logical reasons it is not possible that the probability of two events x_1 and x_2 together is greater than the probability of a single event x_2 . In psychological treatises, this is sometimes referred to as conjunction fallacy. For example, it is incorrect to say that, in the course of climate change, the consequences of rising sea levels and erosion in coastal areas are more likely than the mere rise in sea levels. It is logically not possible that two consequences of climate change together are more probable than just one consequence. Probability is often confused with representativeness. The two consequences may be typical of climate change, but they are not more likely.

- **Importance of the honey bee**

Occasionally the disappearance of the honeybee is mistakenly equated with the disappearance of humanity from planet Earth within a few years. Of course, bees have an important function as pollinators, but such a precise timing for the consequences of the failure of a single influencing factor in a complex system is hardly possible. Furthermore, there are other pollinators besides bees (e.g. beetles, butterflies). Furthermore, many important plants do not need to be visited by insects at all because the wind takes over pollination. These include wheat, corn, rice, rye, barley, oats, and millet. The first three alone provide more than half of all calories consumed by humans. The persistence of the spread of the erroneous statement is astonishing. It is often amplified in the form of a quotation by reference to authorities such as Albert Einstein or prominent bee researchers (e.g. David Seeley).

- **Causes of bird deaths**

The influence of wind turbines on the death of birds is relatively small. The Nature and Biodiversity Conservation Union of Germany (NABU) estimates the number of deaths caused by wind turbines at about 100,000 per year. A greater danger for birds is posed by hunting (e.g. ducks or geese) and power lines. Currently, about 1.2 million birds die in Germany every year due to legal hunting. Birds also collide with power lines regularly. A NABU study from 2017 estimates that 1.5 to 2.8 million birds die every year as a result of a collision with a power line. In particular by interest groups (e.g. opponents of wind power plants), the number of bird deaths caused by wind power plants may well be exaggerated.

- **Nutrition of the world population**

Under current conditions, a 100% conversion to organic farming is not realistic in the long term. It can be expected that the world's population will continue to grow and that agriculture will have to produce considerably higher yields. Therefore, it can be expected that even under conventional conditions, areas under cultivation will have to be greatly expanded. Under organic conditions, this effect would be even stronger because the yields of organic farming are lower. In order to switch completely to organic farming by 2050, in the worst scenario – with large harvest losses and the most unfavorable conditions caused by climate change – 81 percent more land would have to be used for agriculture than today. Against the background of the current challenges, it is rather wishful thinking to switch completely to organic farming.

- **Use of airplane for passenger transport**

Government officials boarded an airplane a good four times as often as they boarded a train: 26,661 train rides are opposed to 109,422 flights. Since the use of airplanes as well as the exemplary function of politicians is criticized by the public, false claims in which the use of the airplane is over-communicated can be spread relatively easily.

- **Smoking**

Scientists from London and San Diego demand in the British Medical Journal to completely ban the sale of filter cigarettes. They argue that the filters are a sham anyway: used to save tobacco and make people believe they make smoking less harmful. In fact, the invention of the filter cigarette in the 1950s was a reaction of the tobacco industry to studies proving that smoking causes lung cancer. Cigarettes with a filter, according to the advertising promise of that time, would absorb some of the tar and thus allow “healthier” smoking. “We now know that this safety argument was a fairy tale – one of many that the tobacco industry invented to sell cigarettes,” write Thomas Novotny of San Diego State University and his colleagues from the London School of Hygiene & Tropical Medicine in their editorial. False claims about cigarettes are widespread. The cigarette industry in particular benefits when filters can save tobacco.

Appendix C: Logit regressions (robustness checks)

Table 10. Determinants to explain the ability to identify false news stories (AME after logit)^(a)

	(1) Consequences of climate change	(3) Importance of the honey bee	(5) Causes of bird deaths	(8) Nutrition of the world population	(10) Use of airplane for passenger transport	(12) Smoking	
Story seen	-.124655 (.0264981)	-.2335778 (.0350608)	-.3276855 (.0760334)	-.1897814 (.0429713)	-.0860692 (.0283409)	-.4166064 (.058442)	
AOT	.0039271 (.0269285)	.0370863 (.0309679)	.0264806 (.0320458)	.015369 (.0354024)	-.0468262 (.0242257)	.0298241 (.037921)	
CRT	-.0269069 (.0128999)	-.008415 (.0157115)	-.0099802 (.0174106)	-.0002946 (.0193525)	.0010583 (.0127217)	-.0016417 (.0206871)	
Female (=1)	-.0181952 (.0425016)	-.0572627 (.0450127)	-.0365189 (.0631184)	.0143068 (.065074)	.0225254 (.0491761)	.010306 (.0658476)	
Conscientiousness	.0333506 (.024015)	-.0014382 (.0263756)	.0337766 (.0285434)	.0142217 (.0322458)	-.0465409 (.0238441)	-.0274062 (.0335473)	
Agreeableness	-.0392782 (.0281506)	.0002256 (.029808)	.0113225 (.0320979)	-.0324016 (.0357374)	-.0517663 (.0258872)	-.0292426 (.036746)	
Openness	-.028613 (.0202388)	-.0290284 (.0230399)	.0173845 (.0241711)	.0173798 (.0271184)	-.007715 (.0203118)	.0185296 (.0289065)	
Extraversion	.0313118 (.0229211)	.036074 (.0252706)	-.0067584 (.0258917)	.0410247 (.0294617)	.0171625 (.021201)	.0641807 (.0219924)	
Neuroticism	.0392659 (.0223419)	.0533152 (.0246355)	-.0226892 (.0262958)	.0251435 (.0293501)	-.0199458 (.0212891)	-.0568661 (.0301323)	
Religion	.0611372 (.0503384)	-.0344716 (.0463566)	-.0312442 (.0550335)	.0446088 (.0611927)	-.0203717 (.0414264)	.0673815 (.0625051)	
Trust mass media	-.0478709 (.0243173)	.0124694 (.0263859)	.0436172 (.0284487)	-.0180946 (.0320743)	-.0240407 (.0222008)	.0375798 (.0325999)	
Social networks	-.019377 (.0194411)	-.023262 (.0223936)	-.0391447 (.0259061)	-.0103106 (.0278763)	.0043825 (.0193425)	.0312287 (.0290444)	
Politics (right)	-.0015547 (.0122903)	.0082014 (.0131536)	-.0026705 (.0141992)	.0101042 (.0160423)	-.0191452 (.0119728)	-.0295429 (.0166161)	
Age	.0035827 (.0059531)	.0164599 (.0061043)	.0068569 (.0076069)	.0008638 (.0078976)	.0088059 (.0055395)	-.0099263 (.0083215)	
Discourse (value-loaded)	.0011635 (.0431968)	-.0547422 (.0450537)	.1517387 (.0419673)	-.0306828 (.0556867)	.034875 (.0461846)	-.0806989 (.0602998)	
Challenges environment (friends)	-.0295831 (.0237469)	.0262139 (.0278933)	-.0214 (.0297124)	-.0137044 (.0323522)	.0086154 (.0247904)	-.0390137 (.0341181)	
Overconfidence environment	.0150443 (.0363755)	-.00041 (.03937)	-.0114328 (.0406814)	.0335649 (.0455412)	.0044673 (.0325267)	.0356872 (.0470869)	
Competence (context)	.0049621 (.0361859)	-.0019794 (.0417857)	.0372568 (.0443456)	.0271422 (.0483282)	-.0090574 (.033158)	-.0593119 (.0490552)	
Risk attitude	-.002667 (.013657)	7.39e-06 (.0144142)	.0149759 (.0165959)	.0064426 (.0180147)	-.0071655 (.0128706)	.023804 (.018896)	
Risk society (context)	-.0322873 (.0298697)	-.1695784 (.0218004)	.0034565 (.0291687)	-.0137687 (.0293951)	-.0517282 (.020995)	.0312508 (.0240374)	
Competence (context)	-.0214656 (.0334215)	.0204121 (.0262386)	-.0347339 (.0300621)	.0247681 (.0287475)	-.0366352 (.0209334)	-.0238326 (.02565)	
	Prob > chi2 (after logit)	0.0008	0.0000	0.0002	0.5573	0.0177	0.0007
	Pseudo R2 (after logit)	0.1885	0.3276	0.1561	0.0540	0.1566	0.1156

(a) Marginal effects, standard Errors in brackets below

Table 11. Determinants to explain the ability to identify false news stories (AME after logit)^(a)

	(2) Microplastics	(4) Food waste	(6) Mushrooms and consequences of Chernobyl	(7) Air quality	(9) Use of coffee paper cups	(11) Waste exports
Story seen	.4092725 (.0368478)	.0981898 (.0190975)	.2962537 (.0292699)	.3409798 (.0455306)	.1350004 (.0254721)	.2264843 (.0230735)
AOT	.0265905 (.0346495)	-.0212884 (.0196281)	.0278354 (.0317715)	.103062 (.0345306)	.052842 (.0197315)	.0308463 (.0279992)
CRT	.0204619 (.0191727)	-.008352 (.0113672)	.0164916 (.0162506)	-.0264735 (.0191676)	.0058423 (.0106139)	-.0173786 (.0167457)
Female (=1)	.0234488 (.0616985)	-.0206688 (.0453471)	-.0291868 (.0605119)	-.0247568 (.0637668)	-.0367204 (.0478187)	-.1252322 (.0658929)
Conscientiousness	.0319104 (.0319697)	-.007075 (.0169568)	-.0262302 (.0299523)	-.0645752 (.031092)	.0334063 (.018354)	.0347427 (.0253185)
Agreeableness	-.0310676 (.0350447)	-.0095607 (.0189519)	-.0394553 (.033198)	.0049629 (.0342153)	-.0112871 (.0197805)	-.0505838 (.0281561)
Openness	.0165616 (.0263649)	.0066306 (.0130343)	.019931 (.0244935)	-.0151044 (.0267977)	.0027033 (.0164583)	-.0011117 (.0224628)
Extraversion	-.0217809 (.0285001)	-.0264873 (.0153716)	-.0448347 (.0263459)	-.0326775 (.0287462)	-.027319 (.0164873)	-.0504525 (.0245564)
Neuroticism	-.0103101 (.0290766)	-.0321028 (.0169879)	-.0234173 (.0259543)	-.0594874 (.0293532)	.015708 (.0181211)	-.0125465 (.0246641)
Religion	.0765995 (.0566753)	-.007699 (.0314031)	-.0316427 (.0550544)	.0100402 (.0587992)	-.0410476 (.0394217)	.0688571 (.0433845)
Trust mass media	-.0077928 (.0322929)	.0100126 (.0175662)	.0514287 (.0282104)	.02804 (.0310811)	-.0237749 (.0197961)	-.0214757 (.0261105)
Social networks	-.0019176 (.0292224)	-.0251645 (.0161043)	-.0181751 (.0262048)	-.050345 (.0276752)	.0061014 (.0156165)	-.0274955 (.0230613)
Politics (right)	-.0138993 (.016016)	-.0157234 (.0089916)	.0253111 (.0150525)	-.0306887 (.0160785)	.0005747 (.0095781)	-.0253034 (.01363)
Age	.0031926 (.0083093)	-.0015338 (.0047288)	.0050317 (.0077339)	-.0037743 (.0082329)	.0080984 (.0054)	.002553 (.0066849)
Discourse (value-loaded)	.0335035 (.0561401)	.0874092 (.0192679)	.0024303 (.0507242)	-.0126212 (.0565155)	.0306066 (.030023)	-.071938 (.0511584)
Challenges environment (friends)	.0345167 (.0326218)	-.0131428 (.017019)	-.0151511 (.0286699)	.0238758 (.0317315)	.0309622 (.0198639)	.0368639 (.0249447)
Overconfidence environment	-.042664 (.0446979)	-.0198711 (.0256918)	.0929981 (.0396401)	-.0253425 (.0441973)	-.0175814 (.028363)	-.0410114 (.0367779)
Competence (context)	.0274737 (.0475335)	.0204573 (.0244987)	-.0306158 (.0432034)	.0692958 (.0469289)	.0043715 (.0271158)	.0386287 (.0394931)
Risk attitude	-.0035961 (.0184186)	.0110518 (.0104982)	.0223139 (.0164319)	-.0122891 (.0185045)	-.0115868 (.0108823)	-.0408614 (.015162)
Risk society (context)	.0090746 (.0378728)	.0383579 (.0179893)	-.008112 (.0277721)	.0923073 (.0303736)	.0227909 (.0184693)	.0585771 (.0238343)
Competence (context)	-.0158501 (.0319278)	.0324749 (.0166781)	.0683471 (.0250886)	-.0474182 (.0305529)	.0068788 (.0155516)	.009801 (.0234615)
	Prob > chi2 (after logit)	0.0000	0.0033	0.0000	0.0000	0.0000
	Pseudo R2 (after logit)	0.1500	0.3154	0.2362	0.1861	0.3205
						0.2302

(a) Marginal effects, standard Errors in brackets below

Appendix D: Risk society & Competence

Risk society

Table 12. Risk society (context) (N=300)^(a)

Variable	Overall	Female	Male
1. Consequences of climate change	4.556667 (.7083748)	4.641618 (.6810574)	4.44 (.7339684)
2. Microplastics	3.97 (.8028586)	4.16763 (.6825854)	3.696 (.8819334)
3. Importance of the honey bee	4.163333 (.8902983)	4.33526 (.8017238)	3.92 (.9554597)
4. Food waste	3.75 (.8698787)	3.976879 (.7846919)	3.44 (.8926221)
5. Causes of bird deaths	3.32 (.8832897)	3.387283 (.8526703)	3.216 (.9209392)
6. Mushrooms and consequences of Chernobyl	2.256667 (.9347199)	2.508671 (.873502)	1.912 (.9159518)
7. Air quality	3.7 (.9271094)	3.901734 (.8467773)	3.416 (.9687371)
8. Nutrition of the world population	4.063333 (.9534249)	4.231214 (.891665)	3.832 (.989754)
9. Use of coffee paper cups	3 (1.060069)	3.277457 (.9844196)	2.6 (1.031754)
10. Use of airplane for passenger transport	3.673333 (1.008304)	3.809249 (1.007833)	3.48 (.9886452)
11. Waste exports	3.633333 (1.037212)	3.872832 (.9560162)	3.304 (1.064258)
12. Smoking	2.876667 (1.210927)	2.99422 (1.158874)	2.728 (1.272387)

(a) Mean (Std. Dev.)

Competence

Table 13. Competence (context) (N=300)^(a)

Variable	Overall	Female	Male
1. Consequences of climate change	3.78 (.7023134)	3.791908 (.6841591)	3.76 (.7339684)
2. Microplastics	3.093333 (.9169286)	3.213873 (.9372359)	2.92 (.8669561)
3. Importance of the honey bee	3.166667 (1.001114)	3.208092 (.9897988)	3.112 (1.025608)
4. Food waste	3.426667 (.8872691)	3.49711 (.8601263)	3.32 (.9210793)
5. Causes of bird deaths	2.29 (.9176274)	2.16185 (.854088)	2.464 (.9799934)
6. Mushrooms and consequences of Chernobyl	2.18 (1.044623)	2.098266 (1.009632)	2.296 (1.085268)
7. Air quality	3.04 (.9423517)	3.00578 (.8924562)	3.072 (1.009439)
8. Nutrition of the world population	3.313333 (1.051431)	3.421965 (1.012126)	3.152 (1.085506)
9. Use of coffee paper cups	3.083333 (1.083344)	3.271676 (1.057177)	2.808 (1.067829)
10. Use of airplane for passenger transport	3.333333 (.9479192)	3.346821 (.9124168)	3.312 (1.003349)
11. Waste exports	2.68 (1.12032)	2.722543 (1.080165)	2.6 (1.170883)
12. Smoking	2.95 (1.162758)	2.809249 (1.132771)	3.136 (1.17325)

(a) Mean (Std. Dev.)